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DESCRIPTION
FLUORESCENT LAMP

Technical Field

5 The present invention relates to a fluorescent lamp that is operated with high frequencies in combination with an electronic ballast.

Background Art

10 A large number of fluorescent lamps are turned on ordinarily with an electronic ballast, in which a capacitor is connected in parallel with a fluorescent lamp on the side opposed to a power source and in series with an electrode coil (hereinafter, this type of electronic ballast is referred to as a "C preheat type electronic ballast"). This is because a suitable electric current through a filament is required to preheat a fluorescent lamp cathode when
15 it starts and to maintain the lighting, and a resonance voltage necessary for the lamp starting and operating should be ensured.

20 The reason this type of electronic ballast has spread most widely is that its circuit configuration is simple and inexpensive. In the C preheat type of electronic ballast, the current through a filament is relatively constant.

25 When a fluorescent lamp combined with the C preheat type of electronic ballast comes to the end of the life by the dissipation of the emissive coating on the electrode coil, the cathode fall voltage is raised. That results in the increase in the current through a filament, which causes
30 the electrode coil to overheat by the excessive current. In addition to the heating from the electrode coil, an electrical discharge generates heat. Thus, the temperature in the vicinity of the electrode increases gradually. Under such circumstances, the lamp operation does not stop occasionally, even if the electrode coil is disconnected. In that case, the glass in the
vicinity of the electrode between its terminals starts to be melted because of the constant current property of the C preheat circuit, so that oscillation of the electronic ballast still continues after leakage of the fluorescent lamp.

35 In order to avoid these problems, the C preheat type of electronic ballast generally has the function of detecting a rise in the lamp voltage in accordance with a rise in the cathode fall voltage and cutting off an oscillation circuit beforehand or lowering an oscillation voltage to a safe level.

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Furthermore, an electronic ballast in which another capacitor is added to the configuration of the above-described C preheat type of electronic ballast so as to be connected in parallel with a fluorescent lamp on the side nearer a power source (hereinafter, this type of electronic ballast is referred to as "double C type electronic ballast") has been put to practical use before. This electronic ballast is doubted to be commercialized again in the future. For the double C type of electronic ballast, a large amount of oscillation voltage is always applied across the fluorescent lamp, even if the electrode coil is disconnected.

However, when the fluorescent lamp, which is combined with such a C preheat type of electronic ballast including a double C type for lighting, comes to the end of the life, the failure of detection of a rise in the lamp voltage, though it rarely occurs, may cause a bulb-end glass in the vicinity of the electrode, e.g., a stem glass to be melted, even if the electronic ballast has the function of detecting a rise in the lamp voltage and cutting off the oscillation circuit beforehand or lowering the oscillation voltage to a safe level. Thus, it has been demanded to solve these problems.

Disclosure of Invention

Therefore, with the foregoing in mind, it is an object of the present invention to provide a fluorescent lamp in which a bulb-end glass is not melted after an electrode coil is disconnected in the last period of electrode life when the fluorescent lamp is turned on with a C preheat type electronic ballast, including a double C type.

A fluorescent lamp of the present invention includes a bulb provided with a pair of electrode coils at both ends thereof. Each of the electrode coils is mounted between two lead wires held by a bulb-end glass. A means for preventing overheating of the bulb-end glass is mounted between the lead wires located between the electrode coil and the bulb-end glass. The means for preventing overheating connects the lead wires electrically just before or after the electrode coil is disconnected.

This configuration can provide a fluorescent lamp that offers the excellent advantage of keeping the bulb-end glass safely at lower temperatures by electrically connecting the lead wires with the means for preventing overheating and of preventing the bulb-end glass from being melted, when an emissive coating is dissipated in the last period of electrode life of the fluorescent lamp, which ordinarily would increase the

temperature of the electrode and its vicinities extraordinarily.

In a fluorescent lamp of the present invention, the means for preventing overheating has a first preferred configuration including a glass member and a first and a second metallic pin for supporting the glass member. One end of each of the first and the second metallic pin is connected to the lead wires, respectively. The first and the second metallic pin are provided not in contact with each other.

According to this preferred configuration, the glass member is heated by a conductive heat, a radiant heat, and intermittent pulse discharge after the emissive coating on the electrode coil in the last period of the life is dissipated and before the electrode is disconnected. In particular, the glass member in the base of the metallic pin is heated effectively by the intermittent pulse discharge. When the electrode coil is disconnected, ionic conduction occurs in the glass member, and thus the glass member starts melting. Furthermore, the two metallic pins may come into contact with each other by the flow of the molten glass member. This contact stops the glass member from melting (i.e., ionic conduction is interrupted). However, the electrical conduction (electronic conduction) between the metallic pins is continued.

Referring to another phenomenon, an increase in the current through a filament after emissive coating dissipation may cause the glass member to start melting because of the heat radiated from the electrode coil, even before the electrode coil is disconnected. In such a case, metal atoms sputtered from the electrode coil enter the molten portion of the glass member and bridge the two metallic pins, so that electronic conduction between the two metallic pins is established. Thus, a transition from the ionic conduction by the melting of the glass member to the electronic conduction occurs between a pair of metallic pins, and thereby the electrical conduction can be continued.

During the above period, the bulb-end glass is not melted, so that the fluorescent lamp can be protected against an excessive heat and maintained safely. Furthermore, even if the lamp in the above condition is restarted after it is turned off, the bulb-end glass is not melted. Thus, the fluorescent lamp can be maintained safely.

According to the first preferred configuration, since the glass member is held by a pair of metallic pins at both ends thereof and each of the metallic pins is connected to the two lead wires, respectively, the glass

member can be mounted easily between the lead wires.

In the first configuration, the means for preventing overheating further may include a metallic container in which the glass member is housed. At least one of the first and the second metallic pin supports the glass member indirectly by supporting the metallic container. The glass member is housed in the metallic container so that a portion of the glass member is exposed to a discharge space.

According to this configuration, when the electrode coil in the last period of the life, in which an emissive coating has been dissipated, is disconnected, the glass member starts melting and conducting ionically. However, since the glass member is housed in the metallic container, the molten state can be maintained in the metallic container without producing a significant deformation of the glass member. During this period, the bulb-end glass is not melted, so that the fluorescent lamp can be maintained safely.

In the above configuration, it is preferable that the portion of the glass member exposed to the discharge space faces to the electrode coil. According to this preferred configuration, the portion of the glass member exposed to the discharge space can be locally heated effectively by the heat radiated from the electrode coil or the intermittent pulse discharge from the opposite electrode. This can ensure that the glass member is melted faster than the bulb-end glass.

Furthermore, it is preferable that one of the metallic pins is inserted into the glass member and the other is connected to the metallic container in which the glass member is housed. This preferred configuration allows the shape of the molten glass member to be maintained in the metallic container. In addition, a set of mounted members (means for preventing overheating) thus formed can be manufactured at a low price.

Furthermore, it is preferable that one of the metallic pins, which has been inserted into the glass member, has a fastener, and that the fastener comes into contact with the end surface of the glass member. Also, the length of the glass member housed in the metallic container in the insertion direction of the metallic pin is longer than the distance from the bottom face of the metallic container to the top in the insertion direction of the metallic pin. According to this preferred configuration, the glass member is fixed between the fastener of one of the metallic pins and the metallic container, and thus it does not fall off in any orientations of the lamp during operation.

In addition, since the length of the glass member is longer than the depth of the metallic container, a portion of the glass member is projected from the metallic container and exposed directly to the source of radiant heat or a discharge space. As a result, the exposed portion of the glass member can be heated effectively by a conductive heat, a radiant heat, and intermittent pulse discharge after the emissive coating on the electrode coil in the last period of the life is dissipated and before the electrode is disconnected.

After the disconnection of the electrode coil, the exposed portion of the glass member can be melted faster than the bulb-end glass. Furthermore, the molten glass member can be maintained at the position where it has been melted (in the metallic container) by the metallic pin having the fastener and the metallic container.

It is preferable that the end of the opening of the metallic container, in which the glass member is housed, is bent inward. According to this preferred configuration, the glass member does not fall off the metallic container before it is melted, regardless of the orientation of the lamp during operation. In addition, after the glass member is melted, the welding surface of the glass member adheres to the inner surface of the metallic container, which can prevent the glass member from falling off the metallic container.

It is preferable that the metallic container in which the glass member is housed is held by the metallic pins via an electrical insulator, and that a pair of metallic pins are provided in close proximity in the glass member. According to this preferred configuration, by adjusting the distance between a pair of metallic pins that are insulated electrically from the metallic container, the impedance between the lead wires in the glass member can be determined easily so as to ensure that the glass member in the metallic container is melted when the electrode coil is disconnected. In addition, this configuration can prevent the molten glass member from flowing out of the metallic container.

It is preferable that the surface of the glass member in the first configuration of the means for preventing overheating is coated with a non-conductive inorganic heat-resisting material.

According to this preferred configuration, the glass member is heated by a conductive heat, a radiant heat, and intermittent pulse discharge after the emissive coating on the electrode coil in the last period of the life is dissipated and before the electrode is disconnected. When the

electrode coil is disconnected, the glass member starts melting and conducting ionically. However, since the outer surface of the glass member is coated with an inorganic heat-resisting material, the molten state can be maintained without producing a significant deformation of the glass member. During this period, the bulb-end glass is not melted, so that the fluorescent lamp can be maintained safely.

In the above configuration, it is preferable that both metallic pins are inserted into the glass member, and that the distance between the metallic pins is substantially equal to or shorter than the insertion length of the metallic pin into the glass member. This preferred configuration can prevent the molten glass member from falling off the metallic pins. In addition, the shape of the glass member can be maintained without being cut off by melting.

It is preferable that the point of the metallic pin in the glass member differs from a portion that continues on to the point in cross section, or has a thickness larger than that of the portion that continues on to the point. This preferred configuration reliably can prevent the molten glass member from falling off the metallic pins.

It is preferable that the inorganic heat-resisting material has a melting point in excess of 200 °C or more above a softening point of the glass member. According to this preferred configuration, the inorganic heat-resisting material is not deformed, even at temperatures at which the glass member is melted. Thus, the glass member coated with the inorganic heat-resisting material is not cut off by melting, so that the shape of the glass member can be maintained substantially against the effect of gravity when a lamp is turned on.

It is preferable that a substance having a lower work function, more preferably cesium oxide, is attached to the surface of the metallic pin. This preferred configuration allows ion bombardment heating caused by main discharge between the electrodes to be concentrated on the metallic pins having a lower work function on the surface. Thus, the glass member rather than the bulb-end glass can be melted certainly.

Next, in a fluorescent lamp of the present invention, the means for preventing overheating has a second preferred configuration including a glass member mounted between the lead wires and a means for preventing falling of the glass member from the lead wires during melting.

According to this preferred configuration, the glass member is

heated by a conductive heat, a radiant heat, and intermittent pulse discharge after the emissive coating on the electrode coil in the last period of the life is dissipated and before the electrode is disconnected. When the electrode coil is disconnected, the glass member starts melting and
5 conducting ionically. However, the glass member does not fall off the lead wires because of the means for preventing falling, and thus the molten state can be maintained. During this period, the bulb-end glass is not melted, so that the fluorescent lamp can be maintained safely.

10 In the above configuration, the means for preventing falling can be provided on the circumference of the glass member. Furthermore, the means for preventing falling can be formed of a non-conductive inorganic heat-resisting material (e.g., ceramic coating) or a metallic band. This configuration can facilitate manufacturing of the means for preventing overheating provided with the means for preventing falling.

15 Next, in a fluorescent lamp of the present invention, it is preferable that the means for preventing overheating has a third preferred configuration including a glass member, and that an electrical volume resistance of the glass member is lower than that of the bulb-end glass. According to this preferred configuration, when the electrode coil is
20 disconnected, the glass member rather than the bulb-end glass is melted and ionically conducted selectively. Thus, the bulb-end glass is not melted, so that the fluorescent lamp can be maintained safely.

Furthermore, in a fluorescent lamp of the present invention, it is preferable that the means for preventing overheating has a fourth preferred
25 configuration including a glass member, and that the electrical conduction between the lead wires through the glass member is continued just before or after the electrode coil is disconnected. According to this preferred configuration, the glass member has been heated by a conductive heat, a radiant heat, and intermittent pulse discharge after the emissive coating on
30 the electrode coil in the last period of the life is dissipated and before the electrode is disconnected. The glass member becomes conductive ionically and is melted selectively before or after the electrode coil is disconnected. Thus, the bulb-end glass is not melted, so that the fluorescent lamp can be maintained safely.

35 In a fluorescent lamp of the present invention, it is preferable that at least a portion of the surface of the bulb-end glass in the lamp is coated with a non-conductive inorganic heat-resisting material. According to this

preferred configuration, the bulb-end glass supporting the lead wires is not heated locally by ion bombardment caused by main discharge between the electrodes. Thus, the glass member in the means for preventing overheating can be melted certainly faster than the bulb-end glass.

5 In a fluorescent lamp of the present invention, it is preferable that the means for preventing overheating is located closer to the electrode coil than to the bulb-end glass. This preferred configuration allows the means for preventing overheating to be subjected more to the heat radiated from the electrode coil that glows red-hot before disconnection. Thus, when the
10 electrode coil is disconnected, the glass member in the means for preventing overheating can be melted faster than the bulb-end glass.

Brief Description of Drawings

FIG. 1 is a partial cutaway front view showing a fluorescent lamp
15 according to Embodiment I - 1 of the present invention.

FIG. 2 is an enlarged cutaway front view showing a substantial part of the fluorescent lamp of FIG. 1.

FIG. 3 is an enlarged perspective view showing a means for preventing overheating of the fluorescent lamp end of FIG. 1.

20 FIG. 4 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 2 of the present invention.

FIG. 5 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment
25 I - 3 of the present invention.

FIG. 6 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 4 of the present invention.

30 FIG. 7 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 5 of the present invention.

FIG. 8 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 6 of the present invention.

35 FIG. 9 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 7 of the present invention.

FIG. 10 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 8 of the present invention.

5 FIG. 11 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 9 of the present invention.

FIG. 12 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 10 of the present invention.

10 FIG. 13 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 11 of the present invention.

FIG. 14 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 12 of the present invention.

FIG. 15 is an enlarged perspective view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment I - 13 of the present invention.

20 FIG. 16 is a partial cutaway front view showing a fluorescent lamp according to Embodiment II - 1 of the present invention.

FIG. 17 is an enlarged cutaway front view showing a substantial part of the fluorescent lamp of FIG. 16.

25 FIG. 18 is an enlarged cutaway front view showing a substantial part of a fluorescent lamp according to Embodiment II - 2 of the present invention.

FIG. 19 is an enlarged cutaway front view showing a substantial part of a fluorescent lamp according to Embodiment II - 3 of the present invention.

30 FIG. 20 is an enlarged cutaway front view showing a substantial part of a fluorescent lamp according to Embodiment II - 4 of the present invention.

FIG. 21 is a partial cutaway front view showing a fluorescent lamp according to Embodiment III of the present invention.

35 FIG. 22 is an enlarged cutaway front view showing a substantial part of the fluorescent lamp of FIG. 21.

FIG. 23 is a partial cutaway perspective view showing a light-emitting tube of a fluorescent lamp according to Embodiment IV of the

present invention.

FIG. 24 is a perspective view of a fluorescent lamp according to Embodiment IV of the present invention.

FIG. 25(A) is a cross-sectional view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment IV of the present invention, and FIG 25(B) is a front view showing a means for preventing overheating of a fluorescent lamp end according to Embodiment IV of the present invention.

FIG. 26 is a block diagram showing a circuit of double C type electronic ballast used for a lighting test of a fluorescent lamp.

FIG. 27 is a block diagram showing a circuit of C preheat type electronic ballast used for a lighting test of a fluorescent lamp.

FIG. 28 is a partial cutaway front view showing a conventional fluorescent lamp.

Best Mode for Carrying Out the Invention

Embodiment I - 1

FIG. 1 shows a fluorescent lamp 10 of Embodiment I - 1 of the present invention. The fluorescent lamp 10 is a 36-watt fluorescent lamp having a bridge junction, including a bulb 2 whose inner surface is coated with phosphors 1 and electrode coils 3 provided at both ends of the bulb 2. The electrode coils 3 have the same structure, so that the detailed description of the mounting portion of one electrode coil 3 is omitted. The bulb 2 is filled with argon gas at appropriate pressures (several 100 Pa) and mercury drops, and a resin base 9 that is made of polyethylene terephthalate and resists temperatures up to 155 °C is attached thereto in the final stage (of the fabrication).

As shown in FIG. 2, first and second lead wires 4a, 4b (made of nickel-plated iron wire) extend from a stem glass 5 attached to the end of the bulb 2 (made of soda-lime glass) to the inside of the lamp. The stem glass 5 is made of lead glass, and hereinafter referred to as "bulb-end glass 5". The electrode coil 3 is mounted between the lead wires 4a and 4b.

Furthermore, a means for preventing overheating 20 is mounted between the lead wires 4a and 4b so as to be placed between the bulb-end glass 5 and the electrode coil 3.

As shown in FIG. 3, the means for preventing overheating 20 includes a glass member 21, which is substantially cylindrical and has an

outer diameter of 2 mm and a length of 3 mm, and two metallic pins 22a, 22b. The glass member 21 is made of soda-lime glass having a softening point of 695 °C. The metallic pins 22a, 22b are made of nickel-plated iron wire and have a wire diameter of 0.5 mm. One end of each of the metallic pins 22a, 22b is connected to the lead wires 4a, 4b, respectively. The metallic pin 22a passes through the glass member 21, and the other end thereof remains projected from the glass member 21. The metallic pin 22b passes through the glass member 21, and the other end thereof is wound around the glass member 21. In this case, the metallic pins 22a, 22b are spaced apart via the glass member 21 and not in contact with each other. The portion of each of the metallic pins 22a, 22b in the glass member 21 is fused thereto. In FIG. 3, the portion of each of the metallic pins 22a, 22b in the glass member 21 is indicated by broken lines.

The means for preventing overheating 20 is mounted between the lead wires 4a and 4b in parallel with the electrode coil 3. The distance between the metallic pins 22a and 22b that are spaced apart in the glass member 21 is about 1 mm. The glass member 21 exposed to a discharge space is located a minimum of 3 mm away from the electrode coil 3.

The fluorescent lamp of this embodiment is combined with a C preheat type of electronic ballast (double C type; a large resonant voltage is generated constantly across a fluorescent lamp, regardless of its condition) for lighting, as shown in FIG. 26. The electronic ballast, which does not have the function of detecting a rise in the voltage of a lamp, includes capacitors C1 and C2. The capacitor C1 is connected in series with the electrode coil 3 of the fluorescent lamp 10 and in parallel with the fluorescent lamp 10 on the side thereof opposed to the power source, and the capacitor C2 is connected in parallel with the fluorescent lamp 10 on the power source side thereof.

For comparison, a fluorescent lamp without a means for preventing overheating (hereinafter, referred to as "comparative lamp") as shown in FIG. 28 is prepared. In FIG. 28, the identical elements to those in FIG. 1 are denoted by the same reference numerals, and the detailed description thereof will be omitted.

In the fluorescent lamp of this embodiment, when an emissive coating is dissipated in the last period of electrode life, the electrode coil 3 generates heat extraordinarily because a cathode fall voltage rises to increase the current flowing into the electrode coil 3. The portion of the

glass member 21 exposed to the discharge space is heated locally by the heat conducted from the electrode coil 3 through the lead wires 4a, 4b and the heat radiated directly from the electrode coil 3, and further by ion bombardment heating caused by intermittent pulse discharge from the electrode coil 3 of the opposite side, so that ion activation is caused in this portion, i.e., the ionic current can be prepared to flow locally into the glass.

When the electrode coil 3 is disconnected, a driving source, in which internal impedance is relatively large and constant-current property is high, for the current that has flowed into the electrode coil 3 via the capacitor C1 requires another closed circuit. As a result, a large amount of ionic current begins to flow instantly into the locally heated portion of the glass member 21 between the metallic pins 22a and 22b. Thus, the metallic pins 22a and 22b are connected electrically, and the glass member 21 begins to melt. At this time, the bulb-end glass 5 does not begin to melt before the glass member 21. Thereafter, the molten portion of the glass member 21 increases gradually. However, since the other end of the metallic pin 22b is wound around the glass member 21, the molten piece of the glass member 21 does not fall off the metallic pins 22a, 22b and remains held by them. Therefore, the closed circuit is maintained so that the electrical conduction between the metallic pins 22a and 22b is continued.

Furthermore, even if the molten piece of the glass member 21 flows along the metallic pins 22a, 22b, the two metallic pins 22a, 22b can come into contact with each other in accordance with the flow of the molten piece, so that the closed circuit is maintained (electronic conduction). Thus, also in the case where the metallic pins are connected directly to each other, the electrical conduction between the metallic pins 22a and 22b can be continued.

When the glass member 21 is melted, the oscillation of the electronic ballast cannot be stopped. However, the resin base 9 can be kept at temperatures lower than the temperature it resists (155 °C). Furthermore, the bulb-end glass 5 is not melted, and thus the fluorescent lamp of this embodiment can be maintained safely.

In the case where the electronic ballast is restarted after it is stopped for a while (when the double C type electronic ballast is used, a lamp starts even if the electrode coil 3 is disconnected), the glass member 21 always can be melted selectively. The reason for this is as follows: The ion bombardment heating caused by intermittent pulse discharge tends to be

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more intensive at the base of the metallic pins 22a, 22b in the vicinity of the glass member 21, where a discharge distance becomes shorter, than at the base of the lead wires 4a, 4b in the vicinity of the bulb-end glass 5; in addition, the distance of the ionic conduction between the metallic pins 22a and 22b in the glass member 21 is shorter than that between the lead wires 4a and 4b in the bulb-end glass 5.

On the other hand, in the case where the electronic ballast is restarted after the metallic pins 22a, 22b come into direct contact with each other and the electronic conduction is achieved, the peripheral glass including the glass member 21 is not melted (i.e., ionic conduction does not occur).

During the period of time when the glass member 21 is in the molten state and the electronic ballast is charged with electricity, the bulb-end glass 5 is not melted.

Furthermore, when the fluorescent lamp is turned on normally before the emissive coating on the electrode coil 3 is dissipated, the impedance of the glass member 21 between the metallic pins 22a and 22b at the temperature at that state is three or more orders of magnitude larger than the resistance of the electrode coil 3. Thus, the current from the driving source that supplies current to the electrode coil 3 via the capacitor C1 flows substantially through the electrode coil 3 alone.

Referring to an example of the process that is different from the above embodiment, an increase in the current through a filament after the emissive coating dissipation in the electrode coil 3 may cause the glass member 21 to start melting because of the radiant heat from the electrode coil 3, even before the electrode coil 3 is disconnected. In this case, metal atoms (tungsten) sputtered from the electrode coil 3 enter the molten glass member 21 and bridge the two metallic pins 22a, 22b, so that the metallic pins 22a, 22b are connected electrically in the glass member 21 (electronic conduction). Thereafter, the same operations as described above are carried out.

On the other hand, in the case where the comparative lamp is combined with the above electronic ballast for lighting, after an emissive coating is dissipated and before the electrode coil 3 is disconnected, the bulb-end glass 5 is locally heated mainly by ion bombardment caused by the intermittent pulse discharge between the electrodes. Following the disconnection of the electrode coil 3, the bulb-end glass 5 is melted certainly,

so that a lamp container (bulb 2) is broken. In addition, the temperature of the resin base 9 is raised, which results in deformation thereof.

A lighting test is conducted in such a manner that the fluorescent lamp of this embodiment is combined with a C preheat type electronic ballast (see FIG. 27), which is not a double C type. In the test, the glass member 21 has been heated until the electrode coil 3 is disconnected after an emissive coating is dissipated, by the heat radiated from the red-hot electrode coil 3, the heat conducted through the lead wires 4a, 4b, and ion bombardment heating caused by the intermittent pulse discharge between the electrodes. As soon as the electrode coil 3 is disconnected, the glass member 21 is melted. In this case, since the other end of the metallic pin 22b is wound around the glass member 21, the molten state can be maintained.

When the electronic ballast is restarted after the fluorescent lamp is turned off, it does not oscillate because the electrode coil 3 has been disconnected. Thus, the present lamp does not start. However, in the case where the molten piece of the glass member 21 flows along the metallic pins 22a, 22b so that the metallic pins 22a, 22b are connected directly to each other, the lamp is activated by this electronic ballast. In such a case, like the above, the electrical conduction between the metallic pins 22a and 22b is continued, the resin base 9 can be kept at temperatures lower than the temperature it resists, and the bulb-end glass 5 is not melted. Thus, the fluorescent lamp of this embodiment can be maintained safely.

In the above embodiment, the metallic pin 22a may remain in the glass member 21 instead of penetrating through it.

Embodiment I - 2

In Embodiment I - 2 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 4. The metallic pins 22a, 22b pass through the glass member 21, and the other end of each of the metallic pins is wound around the glass member 21. This embodiment can provide the same effect as that described above. Furthermore, the metallic pins 22a, 22b are wound not in contact with each other. In FIG. 4, the portion of each of the metallic pins 22a, 22b in the glass member 21 is indicated by broken lines.

Embodiment I - 3

In Embodiment I - 3 of the present invention, a means for

preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 5. The metallic pin 22a is inserted through the glass member 21. The metallic pin 22b does not pass through the glass member 21, and the other end thereof is wound directly
5 around the glass member 21. This embodiment can provide the same effect as that described above. In this case, the end of the metallic pin 22a may be projected from the end surface of the glass member 21 as shown in FIG. 5, i.e., the metallic pin 22a passes through the glass member 21.

Alternatively, it may be positioned in the glass member 21 instead of being
10 projected. In FIG. 5, the portion of the metallic pin 22a in the glass member 21 and that of the metallic pin 22b behind the glass member 21 are indicated by broken lines.

Embodiment I - 4

In Embodiment I - 4 of the present invention, a means for
15 preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 6. The metallic pin 22a is inserted into an insertion hole 21a, which has been provided previously in the glass member 21. In other words, the metallic pin 22a and the glass member 21 are not fused together. This embodiment can provide the same
20 effect as that described above. Furthermore, in this case, it is preferable that the portions of the metallic pin 22a in the vicinity of both ends of the glass member 21 are bent to prevent the glass member 21 from slipping off the metallic pin 22a when the glass member 21 is not melted. In FIG. 6, the insertion hole 21a provided in the glass member 21 and the portion of
25 the metallic pin 22b behind the glass member 21 are indicated by broken lines.

Embodiment I - 5

In Embodiment I - 5 of the present invention, a means for
30 preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 7. The other end of the metallic pin 22a is positioned in the glass member 21. The mid-portion of the metallic pin 22b is wound around the glass member 21, and the other end thereof is positioned in the glass member 21. This embodiment can provide the same effect as that described above. In this case, the metallic
35 pins 22a, 22b in the glass member 21 are not in contact with each other. Furthermore, the end of the metallic pin 22a may be projected from the end surface of the glass member 21, i.e., the metallic pin 22a passes through the

glass member 21, so as not to come into contact with the metallic pin 22b instead of being positioned in the glass member 21, as shown in FIG. 7. In FIG. 7, the portion of each of the metallic pins 22a, 22b in the glass member 21 and the portion of the metallic pin 22b behind the glass member 21 are indicated by broken lines.

Embodiment I - 6

In Embodiment I - 6 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 8. The metallic pin 22a passes through the glass member 21 having a depression 21b formed substantially on a central portion thereof. The other end of the metallic pin 22b is wound around the depression 21b of the glass member 21. This embodiment can provide the same effect as that described above.

Furthermore, the end of the metallic pin 22a may be positioned in the glass member 21 instead of being projected from the end surface of the glass member 21 as shown in FIG. 8. In FIG. 8, the portion of the metallic pin 22a in the glass member 21 and the portion of the metallic pin 22b behind the glass member 21 are indicated by broken lines.

Embodiment I - 7

In Embodiment I - 7 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 9. The other end of the metallic pin 22a is positioned in the glass member 21. A metallic band 23a in the form of a plate, to which the other end of the metallic pin 22b is connected, is provided on the circumference of the glass member 21. This embodiment can provide the same effect as that described above. In this configuration, another metallic pin 24 may be provided so that one end thereof is connected to the metallic band 23a and the other end thereof is positioned in the glass member 21. In such a case, the same effect as that described above can be also obtained. Furthermore, in this embodiment, the end of the metallic pin 22a may be projected from the end surface of the glass member 21, i.e., the metallic pin 22a passes through the glass member 21, instead of being positioned in the glass member 21 as shown in FIG. 9. Also, a metallic band in the form of a net can be used as the metallic band 23a. In FIG. 9, the portion of each of the metallic pins 22a, 24 in the glass member 21 is indicated by broken lines.

Embodiment I - 8

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In Embodiment I - 8 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 10. The glass member 21 includes a hollow glass tube 21c and a glass rod 21d to be inserted into the glass tube 21c. The metallic pins 22a, 22b are inserted into the gap formed between the glass tube 21c and the glass rod 21d. The other ends of each of the metallic pins 22a, 22b that have passed through the glass member 21 are wound around the glass member 21 not in contact with each other. This embodiment can provide the same effect as that described above. In FIG. 10, the portion of each of the metallic pins 22a, 22b in the glass member 21 is indicated by broken lines.

Embodiment I - 9

In Embodiment I - 9 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 11. Two metallic bands 23b in the form of a net are provided near both ends of the glass member 21 so as to be wound around them, respectively. The other ends of each of the metallic pins 22a, 22b are welded electrically to the respective metallic bands 23b. This embodiment can provide the same effect as that described above. Furthermore, a metallic band in the form of a plate without a mesh may be used as the metallic band. The use of these metallic bands increases the area where the molten glass member 21 comes into contact with the metallic bands, so that the molten piece can be maintained readily by the metallic bands. As a result, the reliability of continuous electrical conduction between the metallic pins 22a and 22b can be increased. In FIG. 11, the portion of each of the metallic pins 22a, 22b in the glass member 21 is indicated by broken lines.

Embodiment I - 10

In Embodiment I - 10 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 12. A metallic band 23b is wound around the glass member 21. The other end of the metallic pin 22b that has passed through the glass member 21 is welded electrically to the metallic band 23b. The metallic pin 22a passes through the glass member 21. This embodiment can provide the same effect as that described above. In addition to a metallic band in the form of a net, a metallic band in the form of a plate without a mesh may be used as the metallic band 23b.

Furthermore, the metallic pin 22a may remain in the glass member 21 instead of penetrating through it. In FIG. 12, the portion of each of the metallic pins 22a, 22b in the glass member 21 is indicated by broken lines.

Embodiment I - 11

5 In Embodiment I - 11 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 13. A metallic band 23b is wound around the glass member 21. Unlike the above Embodiments I - 9 and I - 10, the other ends of each of the metallic pins 22a, 22b are not
10 connected to the metallic band 23b. This embodiment can provide the same effect as that described above. In addition to a metallic band in the form of a net, a metallic band in the form of a plate without a mesh may be used as the metallic band 23b. Furthermore, the metallic pins 22a, 22b may remain in the glass member 21 instead of penetrating through it. In
15 FIG. 13, the portion of each of the metallic pins 22a, 22b in the glass member 21 is indicated by broken lines.

Embodiment I - 12

In Embodiment I - 12 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 14. Substantially annular portions 25a, 25b to be shaped into a ring are formed at the other ends of each of the metallic pins 22a, 22b, respectively. The metallic pins 22a, 22b are inserted alternately into the substantially annular portions 25a, 25b. In other words, the metallic pin 22b on the side of one end thereof is
25 inserted through the substantially annular portion 25a at the other end of the metallic pin 22a. Similarly, the metallic pin 22a on the side of one end thereof is inserted through the substantially annular portion 25b at the other end of the metallic pin 22b. The metallic pins 22a, 22b pass through
30 the glass member 21 and are not in contact with each other. This embodiment can provide the same effect as that described above. Furthermore, the radius of each of the substantially annular portions 25a and 25b is about 0.5 mm. In FIG. 14, the portion of each of the metallic pins 22a, 22b in the glass member 21 is indicated by broken lines.

Embodiment I - 13

35 In Embodiment I - 13 of the present invention, a means for preventing overheating 20 of the fluorescent lamp of Embodiment I - 1 has the following configuration, as shown in FIG. 15. The ring-shaped,

substantially annular portions 25a, 25b of the metallic pins 22a, 22b of the fluorescent lamp of the above Embodiment I - 12 are substituted by substantially annular portions 26a, 26b to be shaped into a circular arc (semicircle). This embodiment can provide the same effect as that described above. In FIG. 15, the portion of each of the metallic pins 22a, 22b in the glass member 21 is indicated by broken lines.

In Embodiment I - 12 and I - 13, the shape of the substantially annular portions 25a, 25b, 26a, and 26b is not limited to a ring or a circular arc. For example, they may be shaped into an ellipse or a part of it, a polygon or a part of it, an arch, or the like.

Embodiment II - 1

FIG. 16 shows a fluorescent lamp 10 of Embodiment II - 1 of the present invention. The fluorescent lamp 10 is a 36-watt fluorescent lamp having a bridge junction, including a bulb 2 whose inner surface is coated with phosphors 1 and electrode coils 3 provided at both ends of the bulb 2. The electrode coils 3 have the same structure, so that the detailed description of the mounting portion of one electrode coil 3 is omitted. The bulb 2 is filled with argon gas at appropriate pressures (several 100 Pa) and mercury drops, and a resin base 9 that is made of polyethylene terephthalate and resists temperatures up to 155 °C is attached thereto in the final stage (of the fabrication).

As shown in FIG. 17, two lead wires 4a, 4b (made of nickel-plated iron wire) extend from a stem glass 5 attached to the end of the bulb 2 (made of soda-lime glass) to the inside of the lamp. The stem glass 5 is made of lead glass, and hereinafter referred to as "bulb-end glass 5". The electrode coil 3 is mounted between the lead wires 4a and 4b.

Furthermore, a means for preventing overheating 20 is mounted between the lead wires 4a and 4b so as to be placed between the bulb-end glass 5 and the electrode coil 3.

The means for preventing overheating 20 includes a glass member 21 and metallic pins 22a, 22b (made of nickel-plated iron wire).

The glass member 21 is substantially cylindrical, has an outer diameter of 2 mm and a length of 3 mm, and is made of soda-lime glass having a softening point of 695 °C. The glass member 21 has a concavity formed at one end thereof. The concavity has a depth of 2 mm and an inner diameter of 0.7 mm that is a little larger than the wire diameter of the metallic pin 22a, which will be described later. The glass member 21 is

housed in a metallic container 28 (made of nickel-plated iron wire) with a portion thereof projected from the container. The metallic container 28 is substantially cylindrical and has an inner diameter of about a little more than 2 mm. The distance from the inner bottom face of the container to the top (depth) is 2 mm. The metallic pin 22b is welded to the outer wall of the metallic container 28. The metallic pin 22a is inserted into the concavity of the glass member 21. The glass member 21 is placed between the metallic container 28 and a disk-shaped fastener 27. The fastener 27 has an outer diameter of 2 mm and is provided substantially in the mid-portion of the metallic pin 22a in the longitudinal direction. The means for preventing overheating 20 thus formed is mounted between the lead wires 4a and 4b in parallel with the electrode coil 3 by welding a pair of metallic pins 22a, 22b to the lead wires 4a, 4b. More specifically, the metallic pin 22a having the fastener 27 is inserted into the concavity at one end of the glass member 21, and the end surface of the glass member 21 comes into contact with the disk-shaped fastener 27. The circumferential surface of the glass member 21 between the fastener 27 of the metallic pin 22a and the end of the metallic container 28 on its opening side, i.e., the portion of the glass member 21 projected from the container (having a width of about 1 mm) is exposed directly to a discharge space. The glass member 21 exposed to the discharge space is located a minimum of 3 mm away from the electrode coil 3.

The disk-shaped fastener 27 with the metallic pin 22a is provided opposite to the opening of the metallic container 28. This makes it possible further to prevent the glass member 21 from falling off the metallic container 28 when it is melted. In the embodiment to be described later, e.g., the metallic pin 22a is not provided with the fastener 27 and the opening of the metallic container 28 faces to the electrode coil 3. In such a case, the end of the opening of the metallic container 28 is bent inward to prevent the glass member 21 from falling during melting.

For reference, a conventional fluorescent lamp without the glass member 21 housed in the metal container 28 (hereinafter, referred to as "comparative lamp") as shown in FIG. 28 is prepared.

The fluorescent lamp of this embodiment is combined with a C preheat type electronic ballast (double C type; a large resonant voltage is generated constantly across a fluorescent lamp, regardless of its condition) for lighting, as shown in FIG. 26. The electronic ballast, which does not

have the function of detecting a rise in the voltage of a lamp, includes capacitors C1 and C2: The capacitor C1 is connected in series with the electrode coil 3 of the fluorescent lamp 10 and in parallel with the fluorescent lamp 10 on the side thereof opposed to the power source, and the capacitor C2 is connected in parallel with the fluorescent lamp 10 on the power source side thereof.

As a result, when an emissive coating is dissipated in the last period of electrode life, the electrode coil 3 generates heat extraordinarily because a cathode fall voltage rises to increase the current flowing into the electrode coil 3. The portion of the glass member 21 exposed to the discharge space is heated locally by the heat conducted from the electrode coil 3 through the lead wires 4a, 4b and the heat radiated directly from the electrode coil 3, and further by ion bombardment heating caused by intermittent pulse discharge from the electrode coil 3 of the opposite side, so that ion activation is caused in this portion, i.e., the ionic current can be prepared to flow locally into the glass.

When the electrode coil 3 is disconnected, a driving source for the current that has flowed into the electrode coil 3 via the capacitor C1 requires another closed circuit. As a result, a large amount of ionic current flows instantly into the portion of the glass member 21 exposed to the discharge space (a locally heated portion) between the fastener 27 of the metallic pin 22a and the end of the metallic container 28 on its opening side, and thus this portion is melted. At this time, the bulb-end glass 5 does not begin to melt faster than the glass member 21. Thereafter, the molten portion of the glass member 21 (the locally heated portion) increases gradually. However, since the glass member 21 is housed in the metallic container 28, the surface of the molten portion adheres to the metallic container 28. Thus, the molten piece does not fall off the metallic container 28, regardless of the orientation of the lamp during operation. Therefore, the glass member 21 is not cut off by melting, the closed circuit is not opened, and thus the molten state is maintained. When the glass member 21 is melted, the oscillation of the electronic ballast cannot be stopped. However, the resin base 9 can be kept at temperatures lower than the temperature it resists. Furthermore, the bulb-end glass 5 is not melted, and thus the fluorescent lamp of this embodiment can be maintained safely.

In the case where the electronic ballast is restarted after it is stopped for a while (when the double C type electronic ballast is used, a

lamp starts even if the electrode coil 3 is disconnected), the glass member 21 is always melted first. The reason for this is as follows: The ion bombardment heating caused by intermittent pulse discharge tends to be more intensive at the end of the fastener 27 or the end of the metallic container 28 on its opening side, where a discharge distance becomes shorter, than at the base of the lead wires 4a, 4b in the vicinity of the bulb-end glass 5; in addition, the distance of the ionic conduction between the metallic pin 22a in the glass member 21 and the metallic container 28 is shorter than that between the lead wires 4a and 4b in the bulb-end glass 5. During the period of time when the glass member 21 is in the molten state and the electronic ballast is charged with electricity, the bulb-end glass 5 is not melted, and thus good results can be obtained.

Furthermore, when the fluorescent lamp is turned on normally before the emissive coating on the electrode coil 3 is dissipated, the impedance of the glass member 21 between the fastener 27 of the metallic pin 22a and the end of the metallic container 28 on its opening side is three or more orders of magnitude larger than the resistance of the electrode coil 3. Thus, the current from the driving source that supplies current to the electrode coil 3 via the capacitor C1 flows substantially through the electrode coil 3 alone. When the lamp is turned on normally, the value of the current through the electrode coil 3 is about 250 mA, and that through the glass member 21 between the fastener 27 of the metallic pin 22a and the end of the metallic container 28 on its opening side is about 10 μ A.

On the other hand, in the case where the comparative lamp is combined with the above electronic ballast for lighting, after an emissive coating is dissipated and before the electrode coil 3 is disconnected, the bulb-end glass 5 is locally heated mainly by ion bombardment caused by the intermittent pulse discharge between the electrodes. Following the disconnection of the electrode coil 3, the bulb-end glass 5 is melted certainly, so that a lamp container (bulb 2) is broken. In addition, the temperature of the resin base 9 is raised to exceed the temperature at which the resin base 9 is deformed.

A lighting test is conducted in such a manner that the fluorescent lamp of this embodiment is combined with a C preheat type electronic ballast (see FIG. 27), which is not a double C type. In the test, the glass member 21 has been heated until the electrode coil 3 is disconnected after the emissive coating on the electrode coil 3 is dissipated, by the heat

radiated from the red-hot electrode coil 3, the heat conducted through the lead wires 4a, 4b, and ion bombardment heating caused by the intermittent pulse discharge between the electrodes. As soon as the electrode coil 3 is disconnected, the glass member 21 is melted. In this case, since the glass member 21 is housed in the metallic container 28, the molten state can be maintained in the metallic container 28. Furthermore, when the electronic ballast is restarted after the fluorescent lamp is turned off, the present lamp does not start, and thus desired results can be obtained.

Embodiment II - 2

A means for preventing overheating 20 of the fluorescent lamp of Embodiment II - 2 of the present invention has the following configuration, as shown in FIG. 18. The metallic pin 22a without the fastener 27 is used. The end of the metallic container 28 on its opening side is bent inward, and the bend at the end of the metallic container 28 cuts into the end surface of the glass member 21. This embodiment can prevent a lamp container (bulb 2) from being melted. In addition, the glass member 21 in the metallic container 28 does not flow out after melting. Furthermore, a depression may be formed on the circumferential surface of the glass member 21 midway along the drum portion thereof, and the bend at the end of the metallic container 28 may be cut into that depression (this configuration is not shown).

Embodiment II - 3

A means for preventing overheating 20 of the fluorescent lamp of Embodiment II - 3 of the present invention has the following configuration, as shown in FIG. 19. A portion of the glass member 21, which is not covered with the metallic container 28 and is exposed to a discharge space, i.e., the opening of the metallic container 28, faces directly to the side of the electrode coil 3. This embodiment allows the glass member 21 to be locally heated efficiently by the heat radiated from the electrode coil 3 or intermittent pulse discharge, which ensures that the glass member 21 is melted faster than the bulb-end glass 5, and prevents a lamp container (bulb 2) from being melted.

Embodiment II - 4

A means for preventing overheating 20 of the fluorescent lamp of Embodiment II - 4 of the present invention has the following configuration, as shown in FIG. 20. A pair of metallic pins 22a, 22b and the metallic container 28 are insulated electrically with an electrical insulator 29 made

of a ceramic material. The metallic pins 22a, 22b are inserted into the metallic container 28 to be placed in the glass member 21 in close proximity to each other. As with Embodiment II - 3, the opening of the metallic container 28 faces to the side of the electrode coil 3. When the glass member 21 is melted, it is kept in the metallic container 28 that is supported by the metallic pins 22a, 22b via the electrical insulator 29. By varying the distance between the metallic pins 22a and 22b, the impedance of the glass member 21 between the metallic pins 22a and 22b before and after the electrode coil 3 is disconnected can be designed optimally. Furthermore, like each of the above embodiments, this embodiment can prevent a lamp container (bulb 2) from being melted so that the safety of the lamp can be maintained.

In this embodiment, the end of the metallic container 28 on its opening side may be bent inward, like Embodiment II - 2.

15 Embodiment III

FIG. 21 shows a fluorescent lamp 10 of Embodiment III of the present invention. The fluorescent lamp 10 is a 36-watt fluorescent lamp having a bridge junction, including a bulb 2 whose inner surface is coated with phosphors 1 and electrode coils 3 provided at both ends of the bulb 2. The electrode coils 3 have the same structure, so that the detailed description of the mounting portion of one electrode coil 3 is omitted. The bulb 2 is filled with argon gas at appropriate pressures (several 100 Pa) and mercury drops, and a resin base 9 that is made of polyethylene terephthalate and resists temperatures up to 155 °C is attached thereto in the final stage (of the fabrication).

As shown in FIG. 22, two lead wires 4a, 4b (made of nickel-plated iron wire) extend from a stem glass 5 attached to the end of the bulb 2 (made of soda-lime glass) to the inside of the lamp. The stem glass 5 is made of lead glass, and hereinafter referred to as "bulb-end glass 5". The electrode coil 3 is mounted between the lead wires 4a and 4b.

Furthermore, a means for preventing overheating 20 is mounted between the lead wires 4a and 4b so as to be placed between the bulb-end glass 5 and the electrode coil 3.

The means for preventing overheating 20 includes a glass member 21 and metallic pins 22a, 22b.

The glass member 21 is substantially cylindrical, has an outer diameter of a little less than 2 mm and a length of 6 mm, and is made of

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soda-lime glass having a softening point of 695 °C. A pair of metallic pins 22a, 22b (made of nickel-plated iron wire) are inserted 2 mm into the glass member 21 through each of the end surfaces thereof by welding. The distance between the metallic pins 22a and 22b in the glass member 21 is about 2 mm. Furthermore, about 0.2 g inorganic heat-resisting material 30 (BX-78A manufactured by Nissan Chemical Industries, Ltd., which resists temperatures of 1000 °C or more) is applied to the surface of the glass member 21 to be dried, degassed, calcined, and attached thereto. The glass member 21 is mounted between the lead wires 4a and 4b by welding the metallic pins 22a, 22b to the lead wires 4a, 4b. The glass member 21 is located closer to the electrode coil 3 than to the bulb-end glass 5.

For comparison, a fluorescent lamp without the glass member 21 coated with an inorganic heat-resisting material 30 that adheres to the glass member (hereinafter, referred to as "comparative lamp") as shown in FIG. 28 is prepared.

The fluorescent lamp of this embodiment is combined with a C preheat type electronic ballast (double C type; a large resonant voltage is generated constantly across a fluorescent lamp, regardless of its condition) for lighting, as shown in FIG. 26. The electronic ballast, which does not have the function of detecting a rise in the voltage of a lamp, includes capacitors C1 and C2. The capacitor C1 is connected in series with the electrode coil 3 of the fluorescent lamp 10 and in parallel with the fluorescent lamp 10 on the side thereof opposed to the power source, and the capacitor C2 is connected in parallel with the fluorescent lamp 10 on the power source side thereof.

As a result, in the fluorescent lamp of this embodiment, when an emissive coating is dissipated in the last period of electrode life, the electrode coil 3 generates heat extraordinarily. Thus, the glass member 21 is heated by the heat conducted from the electrode coil 3 through the lead wires 4a, 4b, the heat radiated directly from the electrode coil 3, and ion bombardment heating caused by the main discharge between the electrodes, so that the ionic current is prepared to flow through it.

When the electrode coil 3 is disconnected, a large amount of ionic current flows instantly into the glass member 21, and thus it is melted. However, since the glass member 21 is coated with the non-conductive inorganic heat-resisting material 30 that resists temperatures of 1000 °C or more, the molten state of the glass member can be maintained without the

glass member being cut off by melting. When the glass member 21 is melted, the oscillation of the electronic ballast cannot be stopped. However, the resin base 9 can be kept at temperatures lower than the temperature it resists. Furthermore, the bulb-end glass 5 is not melted, and thus the fluorescent lamp of this embodiment can be maintained safely.

In the case where the electronic ballast is restarted after it is stopped for a while, the glass member 21 is always melted selectively. The reason for this is as follows: The ion bombardment heating caused by main discharge tends to be more intensive at the base of the metallic pins 22a, 22b in the vicinity of the glass member 21, where a discharge distance becomes shorter, than at the base of the lead wires 4a, 4b in the vicinity of the bulb-end glass 5; in addition, the distance of the ionic conduction between the metallic pins 22a and 22b in the glass member 21 is shorter than that between the lead wires 4a and 4b in the bulb-end glass 5. During the period of time when the glass member 21 is in the molten state, the bulb-end glass 5 is not melted.

Furthermore, when the fluorescent lamp is turned on normally before the emissive coating on the electrode coil 3 is dissipated, the impedance of the glass member 21 between the metallic pins 22a and 22b is three or more orders of magnitude larger than the resistance of the electrode coil 3. Thus, the current from the driving source that supplies current to the electrode coil 3 via the capacitor C1 flows substantially through the electrode coil 3 alone.

On the other hand, in the case where the comparative lamp is combined with the above electronic ballast for lighting, after an emissive coating is dissipated and before the electrode coil 3 is disconnected, the bulb-end glass 5 is locally heated mainly by ion bombardment caused by the main discharge. Following the disconnection of the electrode coil 3, the bulb-end glass 5 is melted certainly, so that a lamp container (bulb 2) is broken. In addition, the temperature of the resin base 9 is raised to exceed the temperature at which the resin base 9 is deformed.

A lighting test is conducted in such a manner that the fluorescent lamp of this embodiment is combined with a C preheat type electronic ballast (see FIG. 27), which is not a double C type. In the test, the glass member 21 has been heated until the electrode coil 3 is disconnected after the emissive coating on the electrode coil 3 is dissipated, by ion bombardment heating caused by the main discharge between the electrodes,

the heat radiated from the red-hot electrode coil 3, and the heat conducted through the lead wires 4a, 4b. As soon as the electrode coil 3 is disconnected, the glass member 21 is melted. In this case, since the glass member 21 is coated with the non-conductive inorganic heat-resisting material 30, the molten state of the glass member can be maintained. Furthermore, when the electronic ballast is restarted after the fluorescent lamp is turned off, the present lamp does not start.

In the fluorescent lamp of the above embodiment, the distance between the metallic pins 22a and 22b is substantially equal to the insertion length of each of the metallic pins 22a, 22b into the glass member 21. However, the insertion length may be increased to shorten the distance between the metallic pins 22a and 22b, as long as the distance prevents contact between the metallic pins 22a and 22b when the glass member is melted. In that case, melting of a lamp container (bulb 2) can be prevented just as described above, and thus the safety of the lamp can be maintained. The insertion length of the metallic pins 22a, 22b into the glass member 21 by welding preferably is selected so that the glass member 21 does not slip off the metallic pins 22a, 22b when melted.

In the fluorescent lamp of the above embodiment, the cross section or the thickness of the point of each of the metallic pins 22a, 22b in the glass member 21 is the same as that of the portion of the metallic pin that continues on to the point. However, in the glass member 21, the cross section of the point of the metallic pin may be shaped to be different from that of the portion of the metallic pin that continues on to the point and/or the thickness of the point may be larger than that of the other portions. This makes it difficult for the glass member 21 to slip off the metallic pins 22a, 22b when melted, thereby increasing the reliability of the function that prevents the lamp container (bulb 2) from being melted.

Furthermore, as with the fluorescent lamp of the above embodiment, using an inorganic heat-resisting material having a melting point in excess of at least 200 °C above the softening point of the glass member 21 to be used with the material as the inorganic heat-resisting material 30 can prevent the molten glass member 21 from being cut off by melting.

When the metallic pins to which a substance having a lower work function, such as cesium oxide or the like is attached are used in place of the metallic pins 22a, 22b of the fluorescent lamp of Embodiments I - III, ion bombardment heating caused by the main discharge between the electrodes

after emissive coating dissipation can be concentrated on the metallic pins 22a, 22b, and thereby increasing the reliability of the function that prevents the lamp container (bulb 2) from being melted.

Embodiment IV

5 In the above Embodiments I - III, the glass member 21 that constitutes a means for preventing overheating is mounted between the lead wires 4a and 4b via the metallic pins 22a, 22b. However, the present invention is not limited to such a configuration. For example, the glass member may be mounted directly between the lead wires 4a and 4b without
10 using the metallic pins 22a, 22b.

Furthermore, in the above Embodiments I - III, a bulb-end glass is the stem glass 5. However, the present invention is not limited to such a configuration. For example, the present invention can be applied to the case where the bulb-end glass is an end glass formed by a pinch-seal
15 method.

In Embodiment IV, a pinch-seal-type fluorescent lamp is provided so that a mounted bead is used as the means for preventing overheating 20 of the present invention.

FIG. 23 shows a configuration of a light-emitting tube 11 of a
20 compact fluorescent lamp of Embodiment IV of the present invention. The light-emitting tube 11 includes six bulbs 2 (straight glass tube, made of soda-lime glass) that are joined with bridge junctions so as to form a series of discharge paths. A pair of electrode coils 3, 3 made of tungsten are provided on both tube's ends of the light-emitting tube 11. Each electrode
25 coil 3 is mounted between a pair of lead wires 4a and 4b (made of nickel-plated iron wire). A pair of lead wires 4a, 4b are held by a bulb-end glass 12 of the bulb 2, with which the light-emitting tube 11 is sealed hermetically. A part of each of the lead wires 4a, 4b between the electrode coil 3 and the bulb-end glass 12 is bent so that the space between the lead
30 wires is narrowed. A bead glass 31 is mounted on the bend. The bead glass 31 controls the space between a pair of lead wires 4a and 4b, and thus the electrode coil 3 is held stably (i.e., so-called a bead mounting method). The inner surface of the main part of the light-emitting tube 11 is coated with phosphors 1, and the tube is filled with mercury and argon gas at a
35 pressure of 400 Pa. As shown in FIG. 24, a resin base 9' that is made of polyethylene terephthalate and resists temperatures up to 155 °C is attached to the light-emitting tube 11 so as to complete the fluorescent lamp

10'.

In the 32-watt compact fluorescent lamp 10' thus formed, soda-lime glass having a softening point of 695 °C and a lower volume resistance is employed as the bead glass 31 as a means for preventing overheating.

5 According to this configuration, at the end of the life of a lamp, the temperature of the bead glass 31, which is close to the electrode coil 3, is higher than that of the bulb-end glass 12. Thus, the value of the volume resistance of the bead glass 31 is lower. Furthermore, the distance between the lead wires 4a and 4b is narrower at the portion where the lead wires are
10 held by the bead glass 31 than that where they are held by the bulb-end glass 12. Thus, the electrical insulation provided by the bead glass 31 is lower than that by the bulb-end glass 12. Although the bead glass 31 and the bulb-end glass 12 are made of the same soda-lime glass, only the portion of the bead glass 31 is melted selectively to cause a breakdown. Because of
15 this lower electrical insulating property of the bead glass 31, it can act as a means for preventing overheating at the end of lamp life. This can prevent reliably the bulb-end glass 12 from being melted and causing a breakdown.

When the bead glass 31 is melted, to prevent it from falling because of, e.g., the vibration of a lamp, the above embodiment can have the
20 following configuration.

For example, as shown in FIG. 25(A), an inorganic material, such as a ceramic coating 32 of $\text{Al}_2\text{O}_3\text{-SiO}_2$ whose melting point is higher than that of the bead glass 31 is provided on the outer surface of the bead glass 31. This configuration can prevent the bead glass 31 from falling because the
25 ceramic coating 32 is not melted, even if the bead glass 31 is melted. The ceramic coating 32 is formed by a relatively simple manufacturing process, in which the bead glass 31 is coated by spraying suspension solutions of $\text{Al}_2\text{O}_3\text{-SiO}_2$ to be dried, and burned.

Alternatively, as shown in FIG. 25(B), a metallic band 33 of stainless
30 steel is provided on the circumference of the bead glass 31 so as not to form a short circuit between the lead wires 4a and 4b. This configuration also reliably can prevent the bead glass 31 from falling. Furthermore, a metallic band in the form of a wire net may be used as the metallic band 33.

The mechanism that prevents the bead glass 31 from falling is not
35 limited to those shown in FIGS. 25(A) and 25(B). For example, it is possible to wind the bead glass 31 with a wire of metal or the like or to insert a metal plate, a metal wire net, a metal rod, or the like into the glass

member 31.

5 In the fluorescent lamp of Embodiments I - IV, a non-conductive inorganic heat-resisting material may be applied in the same manner as in Embodiment III to the surface of the bulb-end glass 5, 12 on the side of the electrode coil 3 including the area between the lead wires 4a and 4b. This configuration can prevent the bulb-end glass 5, 12 from being heated by ion bombardment caused by the main discharge between the electrodes, which ensures that the means for preventing overheating can be melted faster than the bulb-end glass 5, 12.

10 Furthermore, the means for preventing overheating (glass member 21, 31) may be located closer to the electrode coil 3 than to the bulb-end glass 5, 12 so as to be subjected readily to the heat radiated from the electrode coil 3 that glows red-hot after emissive coating dissipation and the heat conducted through the lead wires 4a, 4b, and thereby increasing the reliability of the function that prevents a lamp container (bulb 2) from being melted.

15 Furthermore, a fluorescent lamp having a bridge junction has been described in the above Embodiments I - IV. However, the fluorescent lamp of the present invention is not limited thereto. The present invention can be widely applied to the well-known fluorescent lamps, such as a straight-tube fluorescent lamp, a circular-shaped fluorescent lamp, or the like.

20 The invention may be embodied in other forms without departing from the spirit or essential characteristics thereof. The embodiments disclosed in this application are to be considered in all respects as illustrative and not limiting. The scope of the invention is indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

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